WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2003ND25B

Title: Comparative Study of Fossil and Extant Fish Growth: Including Analyses of Mean Annual Temperature in the Geologic Record

Project Type: Research

Focus Categories: Surface Water, Wetlands, Climatological Processes

Keywords: Climatic change, Fossil records, global warming, Fish Growth

Start Date: 03/01/2005

End Date: 02/28/2006

Federal Funds: $13,130

Non-Federal Matching Funds: $26,685

Congressional District: 1

Principal Investigators:
Allan Ashworth

G. Padmanabhan

Abstract

This Fellowship research focuses on the comparative growth of several groups of fish. Specifically, we will contrast growth of fish in the fossil record to that of living fish to determine mean annual temperature change in the geologic record. To thoroughly address our specific objectives, we gathered data to examine the linkages of fish to climate at the population level and within the geologic record. The analyses are important for fishery biologists and ecologists in North Dakota who are interested in the implications of climatic change on surface water resources and fish. For example, the study of a fossil glacial lake site in North Dakota has produced fossil specimens of contemporary species of fish. We have found the environment of the fossil lake changed from a cool wet climate with tamarack, black spruce, birch and aspen to a contemporary prairie-pothole region. The change occurred over a period of a thousand of years thus giving us insight into the effects of climate change and subsequently drought on fish abundance. We published a manuscript that reports fish abundance fluctuated on 160-year cycles in relation to drought and periods of drought were correlated with low abundance of fish. Furthermore, overall fish abundance increased with temperature. We then looked at the

response of fish on longer time scales (100 million years) to addresses the trends in fish movement across latitude and through time. We examined the age – latitude relationships for 54 taxa within 37 families of freshwater fishes from over 150 fossil localities from the Late Cretaceous to the Pliocene (~100 to 2 mya) in North America. We compared the changes in latitudinal data with changes in paleotemperatures based on the oxygen isotope analyses of deep-sea benthic foraminifera. A significant relationship between latitude and climate suggests that fish populations are shifting in response to changing thermal conditions and can explain many of the patterns in long-term fish dispersal. Since fish are responding to climate at the population level in a lake and at the species level in the geologic record, we are now examining the response of growth to climate for the members of the pike, mooneye, and freshwater perch families. We have found significant relationships between growth and climate for five out of seven contemporary species examined. Enough data did not exist in the published literature for constructing relationships for the remaining two species. In addition, we have aged hundreds of fossil fish in museum collections and are nearly poised to start our paleoclimatic analyses. Given the potential for global warming and the questions surrounding the response of fishes, an understanding of fish growth in relation to temperature and the correlations between fossil fish and climatic warming in the geologic record will provide insight into the effects of climatic warming on contemporary fish species.